

WHAT IS CLAIMED IS:

1. A millimeter wave band transmitter comprising:
a frequency arranging circuit coupling a plurality of input modulation signal waves while frequency-converting at least one of said plurality of input modulation signal waves to generate a multiplex signal wave having respective frequency bands of said plurality of input modulation signal waves arranged on a frequency axis independent of each other,

a frequency up-converter up-converting said multiplex signal wave to a millimeter wave band to generate a millimeter wave band multiplex signal wave, and

a transmission circuit transmitting said millimeter wave band multiplex signal wave.

2. A millimeter wave band receiver comprising:
a reception circuit receiving a millimeter wave band multiplex signal wave generated by coupling a plurality of modulation signal waves while frequency-converting at least one of said plurality of modulation signal waves, and having respective frequency bands of said plurality of modulation signal waves arranged on a frequency axis independent of each other,

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a frequency down-converter down-converting said millimeter wave band multiplex signal wave from a millimeter wave band to generate a *down-converted* multiplex signal wave, and

down converted
a frequency rearranging circuit dividing said multiplex signal wave while frequency-converting said at least one modulation signal wave to restore said plurality of modulation signal waves respectively having the former frequency bands.

3. A millimeter wave band communication apparatus comprising:
a millimeter wave band transmitter receiving a plurality of input modulation signal waves to transmit a millimeter wave band multiplex

signal wave, said millimeter wave band transmitter including

5 a frequency arranging circuit coupling said plurality of input modulation signal waves while frequency-converting at least one of said plurality of input modulation signal waves to generate a multiplex signal wave having respective frequency bands of said plurality of input modulation signal waves arranged on a frequency axis independent of each other,

10 a frequency up-converter up-converting said multiplex signal wave to the millimeter wave band to generate said millimeter wave band multiplex signal wave, and

15 a transmission circuit transmitting said millimeter wave band multiplex signal wave; and

a millimeter wave band receiver receiving said transmitted millimeter wave band multiplex signal wave to restore said plurality of input modulation signal waves, said millimeter wave band receiver including

20 a reception circuit receiving said millimeter wave band multiplex signal wave,

a frequency down-converter down-converting said millimeter wave band multiplex signal wave from the millimeter wave band to generate said multiplex signal wave, and

25 a frequency rearranging circuit dividing said multiplex signal wave while frequency-converting said at least one modulation signal wave to restore said plurality of input modulation signal waves respectively having the former frequency bands.

4. A millimeter wave band transmitter comprising:

a first input terminal of a first modulation signal wave,

a second input terminal of a second modulation signal wave,

5 a first local oscillator generating a first local oscillation signal of a first local oscillation frequency,

a first frequency mixer mixing said first modulation signal wave with said first local oscillation signal to frequency-convert said first

modulation signal wave,

10 a signal combiner coupling said frequency-converted first modulation signal wave with said second modulation signal wave to generate a multiplex signal wave,

a second local oscillator generating a second local oscillation signal of a second local oscillation frequency,

15 a second frequency mixer mixing said multiplex signal wave with said second local oscillation signal to up-convert said multiplex signal wave to the millimeter wave band to generate a millimeter wave band multiplex signal wave, and

a transmission circuit transmitting said millimeter wave band multiplex signal wave.

5 5. The millimeter wave band transmitter according to claim 4, wherein said first frequency mixer up-converts said first modulation signal wave,

further comprising a filter extracting and applying to said signal combiner a lower side band signal of said up-converted first modulation signal wave.

6. The millimeter wave band transmitter according to claim 5, wherein said first local oscillation frequency is set so that said lower side band signal of said up-converted first modulation signal wave is arranged adjacent a higher frequency side of said second modulation signal wave.

7. The millimeter wave band transmitter according to claim 6, wherein said first local oscillation frequency is set to a frequency from a lower microwave band to a higher microwave band.

8. The millimeter wave band transmitter according to claim 4, wherein said millimeter wave band multiplex signal wave includes said first local oscillation signal up-converted to the millimeter wave band.

9. The millimeter wave band transmitter according to claim 4,
wherein said second local oscillator receives said first local oscillation signal
from said first local oscillator to generate said second local oscillation signal
by frequency multiplying or injection locking according to said first local
5 oscillation signal.

10. The millimeter wave band transmitter according to claim 8,
wherein said second local oscillator receives said first local oscillation signal
from said first local oscillator to generate said second local oscillation signal
by frequency multiplying or injection locking according to said first local
5 oscillation signal.

11. The millimeter wave band transmitter according to claim 4,
wherein at least one of said first and second modulation signal waves is a
modulation signal wave having a user's individual information signal wave
multiplexed over a part or entirety of said at least one of said first and
5 second modulation signal waves.

12. A millimeter wave band receiver comprising:
a reception circuit receiving a transmitted millimeter wave band
multiplex signal wave that is a multiplex signal wave up-converted to a
millimeter wave band by a second local oscillation frequency, said multiplex
5 signal wave generated by coupling first and second modulation signal waves
after said first modulation signal wave is frequency-converted by a first local
oscillation frequency, f_{LO_1}

a first local oscillator generating a first local oscillation signal of said
second local oscillation frequency, $LO_1 = f_{LO_2}$

10 a first frequency mixer mixing said millimeter wave band multiplex
signal wave with said first local oscillation signal to down-convert said
millimeter wave band multiplex signal wave from the millimeter wave band
to generate said multiplex signal wave,

15 a signal distributor dividing said down-converted multiplex signal
wave into said frequency-converted first modulation signal wave, and said

second modulation signal wave,

a second local oscillator generating a second local oscillation signal of said first local oscillation frequency, $LO_2 = f_{LO_1}$

a second frequency mixer mixing said frequency-converted first modulation signal wave with said second local oscillation signal to frequency-convert again said first modulation signal wave to restore said first modulation signal wave,

a first output terminal providing said restored first modulation signal wave, and

a second output terminal providing said second modulation signal wave supplied from said signal distributor.

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13. The millimeter wave band receiver according to claim 12, wherein

said transmitted millimeter wave band multiplex signal wave includes a signal component of said first local oscillation frequency up-converted to the millimeter wave band,

said signal distributor extracts a signal component of said first local oscillation frequency from said down-converted multiplex signal wave, and

said second local oscillator generates said second local oscillation signal by a phase locking loop according to said extracted first local oscillation frequency signal component.

14. The millimeter wave band receiver according to claim 12, wherein said first local oscillator receives said second local oscillation signal from said second local oscillator to generate said first local oscillation signal by frequency multiplying or injection locking according to said second local oscillation signal.

15. The millimeter wave band receiver according to claim 13, wherein said first local oscillator receives said second local oscillation signal from said second local oscillator to generate said first local oscillation signal by frequency multiplexing or injection locking according to said second local

5 oscillation signal.

16. The millimeter wave band receiver according to claim 12,
wherein at least one of said first and second modulation signal waves is a
modulation signal wave having a user's individual information signal wave
multiplexed over a part or entirety of said at least one of said first and
5 second modulation signal waves.

17. A millimeter wave band communication apparatus comprising:
a millimeter wave band transmitter receiving first and second input
modulation signal waves to transmit a millimeter wave band multiplex
signal wave, said millimeter wave band transmitter including

5 a first input terminal of said first modulation signal wave,
a second input terminal of said second modulation signal
wave,

a first local oscillator generating a first local oscillation
signal of a first local oscillation frequency,

10 a first frequency mixer mixing said first modulation signal
wave with said first local oscillation signal to frequency-convert said first
modulation signal wave,

a signal combiner coupling said frequency-converted first
modulation signal wave with said second modulation signal wave to
15 generate a multiplex signal wave,

a second local oscillator generating a second local oscillation
signal of a second local oscillation frequency,

a second frequency mixer mixing said multiplex signal wave
with said second local oscillation signal to up-convert said multiplex signal
20 wave to the millimeter wave band to generate said millimeter wave band
multiplex signal wave, and

a transmission circuit transmitting said millimeter wave
band multiplex signal wave; and

a millimeter wave band receiver receiving said millimeter wave band
25 multiplex signal wave to restore said first and second modulation signal

waves, said millimeter wave band receiver including

a reception circuit receiving said transmitted millimeter wave band multiplex signal wave,

30 a third local oscillator generating a third local oscillation signal of said second local oscillation frequency,

a third frequency mixer mixing said millimeter wave band multiplex signal wave with said third local oscillation signal to down-convert said millimeter wave band multiplex signal wave from the millimeter wave band to generate said multiplex signal wave,

35 a signal distributor dividing said down-converted multiplex signal wave into said frequency-converted first modulation signal wave, and said second modulation signal wave,

a fourth local oscillator generating a fourth local oscillation signal of said first local oscillation frequency,

40 a fourth frequency mixer mixing said frequency-converted first modulation signal wave with said fourth local oscillation signal to frequency-convert again said first modulation signal wave to restore said first modulation signal wave,

45 a first output terminal providing said restored first modulation signal wave, and

a second output terminal providing a second modulation signal wave supplied from said signal distributor.

18. The millimeter wave band communication apparatus according to claim 17, wherein said first frequency mixer up-converts said first modulation signal wave,

5 said millimeter wave band transmitter further comprising a filter extracting and applying to said signal distributor a signal of a lower side band of said up-converted first modulation signal wave.

19. The millimeter wave band communication apparatus according to claim 18, wherein said first local oscillation frequency is set so that said lower side band signal of said up-converted first modulation signal wave is

5 arranged adjacent a higher frequency side of said second modulation signal wave.

20. The millimeter wave band communication apparatus according to claim 19, wherein said first local oscillation frequency is set to a frequency from a lower microwave band to a higher microwave band.

21. The millimeter wave band communication apparatus according to claim 17, wherein

5 said transmitted millimeter wave band multiplex signal wave includes a signal component of said first local oscillation frequency up-converted to the millimeter wave band,

said signal distributor extracts a signal component of said first local oscillation frequency from said down-converted multiplex signal wave, and

10 said fourth local oscillator generates said fourth local oscillation signal by a phase locking loop according to said extracted first local oscillation frequency signal component.

22. The millimeter wave band communication apparatus according to claim 17, wherein said second local oscillator receives said first local oscillation signal from said first local oscillator to generate said second local oscillation signal by frequency multiplying or injection locking according to
5 said first local oscillation signal,

wherein said third local oscillator receives said fourth local oscillation signal from said fourth local oscillator to generate said third local oscillation signal by frequency multiplexing or injection locking according to said fourth local oscillation signal.

23. The millimeter wave band communication apparatus according to claim 21, wherein said second local oscillator receives said first local oscillation signal from said first local oscillator to generate said second local oscillation signal by frequency multiplexing or injection locking according to
5 said first local oscillation signal,

wherein said third local oscillator receives said fourth local oscillation signal from said fourth local oscillator to generate said third local oscillation signal by frequency multiplexing or injection locking according to said fourth local oscillation signal.

5 24. The millimeter wave band communication apparatus according to claim 17, wherein at least one of said first and second modulation signal waves is a modulation signal wave having a user's individual information signal wave multiplexed over a portion or entirety of said at least one of said first and second modulation signal waves.

25. A millimeter wave band transmitter comprising:
a first input terminal of a first modulation signal wave,
a second input terminal of a second modulation signal wave,
a third input terminal of a third modulation signal wave,
5 a first signal combiner coupling said first modulation signal wave with said third modulation signal wave to generate a first multiplex signal wave,
a first local oscillator generating a first local oscillation signal of a first local oscillation frequency,
10 a first frequency mixer mixing said first multiplex signal wave with said first local oscillation signal to frequency-convert said first multiplex signal wave,
a second signal combiner coupling said frequency-converted first multiplex signal wave with said second modulation signal wave to generate
15 a second multiplex signal wave,
a second local oscillator generating a second local oscillation signal of a second local oscillation frequency,
a second frequency mixer mixing said second multiplex signal wave with said second local oscillation signal to up-convert said second multiplex
20 signal wave to the millimeter wave band to generate a millimeter wave band multiplex signal wave, and
a transmission circuit transmitting said millimeter wave band

multiplex signal wave.

26. The millimeter wave band transmitter according to claim 25, wherein said first frequency mixer up-converts said first multiplex signal wave,

5 further comprising a filter extracting and applying to said second signal combiner a signal of a lower side band of said up-converted first multiplex signal wave.

27. The millimeter wave band transmitter according to claim 26, wherein said first local oscillation frequency is set so that said lower side band signal of said up-converted first multiplex signal wave is arranged adjacent a higher frequency side of said second modulation signal wave.

28. The millimeter wave band transmitter according to claim 27, wherein said first local oscillation frequency is set to a frequency from a lower microwave band to a higher microwave band.

29. The millimeter wave band transmitter according to claim 25, wherein said millimeter wave band multiplex signal wave includes said first local oscillation signal up-converted to the millimeter wave band.

30. The millimeter wave band transmitter according to claim 25, wherein said second local oscillator receives said first local oscillation signal from said first local oscillator to generate said second local oscillation signal by frequency multiplexing or injection locking according to said first local
5 oscillation signal.

31. The millimeter wave band transmitter according to claim 29, wherein said second local oscillator receives said first local oscillation signal from said first local oscillator to generate said second local oscillation signal by frequency multiplexing or injection locking according to said first local
5 oscillation signal.

32. The millimeter wave band transmitter according to claim 25,
wherein at least one of said first, second and third modulation signal waves
is a modulation signal wave having a user's individual information signal
wave multiplexed over a part or entirety of said at least one modulation
signal wave.

33. A millimeter wave band receiver comprising:
a reception circuit receiving a transmitted millimeter wave band
multiplex signal wave which is a second multiplex signal wave up-converted
to a millimeter wave band by a second local oscillation frequency, said
second multiplex signal wave generated by coupling a first multiplex signal
wave generated by coupling first and third modulation signal waves with a
second modulation signal wave after said first multiplex signal wave is
frequency-converted by a first local oscillation frequency,

a first local oscillator generating a first local oscillation signal of said
second local oscillation frequency,

a first frequency mixer mixing said millimeter wave band multiplex
signal wave with said first local oscillation signal to down-convert said
millimeter wave band multiplex signal wave from the millimeter wave band
to generate said second multiplex signal wave,

a first signal distributor dividing said down-converted second
multiplex signal wave into said frequency-converted first multiplex signal
wave, and said second modulation signal wave,

a second local oscillator generating a second local oscillation signal of
said first local oscillation frequency,

a second frequency mixer mixing said frequency-converted first
multiplex signal wave with said second local oscillation signal to frequency-
convert again said first multiplex signal wave to restore said first multiplex
signal wave,

a second signal distributor dividing said restored first multiplex
signal wave into said first modulation signal wave and said third
modulation signal wave,

a first output terminal providing said first modulation signal wave

supplied from said second signal distributor,

30 a second output terminal providing said second modulation signal wave supplied from said first signal distributor, and

a third output terminal providing said third modulation signal wave supplied from said second signal distributor.

34. The millimeter wave band receiver according to claim 33, wherein

5 said transmitted millimeter wave band multiplex signal wave includes a signal component of said first local oscillation frequency up-converted to the millimeter wave band,

said first signal distributor extracts a signal component of said first local oscillation frequency from said down-converted second multiplex signal wave, and

10 said second local oscillator generates said second local oscillation signal by a phase locking loop according to said extracted first local oscillation frequency signal component.

35. The millimeter wave band receiver according to claim 33, wherein said first local oscillator receives said second local oscillation signal from said second local oscillator to generate said first local oscillation signal by frequency multiplexing or injection locking according to said second local oscillation signal.

36. The millimeter wave band receiver according to claim 34, wherein said first local oscillator receives said second local oscillation signal from said second local oscillator to generate said first local oscillation signal by frequency multiplexing or injection locking according to said second local oscillation signal.

37. The millimeter wave band receiver according to claim 33, wherein at least one of said first, second and third modulation signal waves is a modulation signal wave having a user's individual information signal

5 wave multiplexed over a part or entirety of said at least one modulation
signal wave.

38. A millimeter wave band communication apparatus comprising:
a millimeter wave band transmitter receiving first, second and third
input modulation signal waves to transmit a millimeter wave band
multiplex signal wave, said millimeter wave band transmitter including

5 a first input terminal of said first modulation signal wave,
a second input terminal of said second modulation signal
wave,

a third input terminal of said third modulation signal wave,
a first signal combiner coupling said first modulation signal
10 wave with said third modulation signal wave to generate a first multiplex
signal wave,

a first local oscillator generating a first local oscillation
signal of a first local oscillation frequency,

15 a first frequency mixer mixing said first multiplex signal
wave with said first local oscillation signal to frequency-convert said first
multiplex signal wave,

a second signal combiner coupling said frequency-converted first
multiplex signal wave with said second modulation signal wave to generate
a second multiplex signal wave,

20 a second local oscillator generating a second local oscillation
signal of said second local oscillation frequency,

a second frequency mixer mixing said second multiplex
signal wave with said second local oscillation signal to up-convert said
second multiplex signal wave to the millimeter wave band to generate said
25 millimeter wave band multiplex signal wave, and

a transmission circuit transmitting said millimeter wave
band multiplex signal wave; and

a millimeter wave band receiver receiving said millimeter wave band
multiplex signal wave to restore said first, second and third modulation
30 signal waves, said millimeter wave band receiver including

a reception circuit receiving said transmitted millimeter wave band multiplex signal wave,

a third local oscillator generating a third local oscillation signal of said second local oscillation frequency,

35 a third frequency mixer mixing said millimeter wave band multiplex signal wave with said third local oscillation signal to down-convert said millimeter wave band multiplex signal wave from the millimeter wave band to generate said second multiplex signal wave,

40 a first signal distributor dividing said down-converted second multiplex signal wave into said frequency-converted first multiplex signal wave, and said second modulation signal wave,

a fourth local oscillator generating a fourth local oscillation signal of said first local oscillation frequency,

45 a fourth frequency mixer mixing said frequency-converted first multiplex signal wave with said fourth local oscillation signal to frequency-convert again said first multiplex signal wave to restore said first multiplex signal wave,

50 a second signal distributor dividing said restored first multiplex signal wave into said first modulation signal wave and said third modulation signal wave,

a first output terminal providing said first modulation-signal wave supplied from said second signal distributor,

a second output terminal providing said second modulation signal wave supplied from said first signal distributor, and

55 a third output terminal providing said third modulation signal wave supplied from said second signal distributor.

39. The millimeter wave band communication apparatus according to claim 38, wherein said first frequency mixer up-converts said first multiplex signal wave,

5 said millimeter wave band transmitter further including a filter extracting and applying to said second signal combiner a signal of a lower side band of said up-converted first multiplex signal wave.

40. The millimeter wave band communication apparatus according to claim 39, wherein said first local oscillation frequency is set so that said lower side band signal of said up-converted first multiplex signal wave is arranged adjacent to a higher frequency side of said second modulation
5 signal wave.

41. The millimeter wave band communication apparatus according to claim 40, wherein said first local oscillation frequency is set to a frequency from a lower microwave band to a higher microwave band.

42. The millimeter wave band communication apparatus according to claim 38, wherein
said transmitted millimeter wave band multiplex signal wave includes a signal component of said first local oscillation frequency up-
5 converted to the millimeter wave band,
said first signal distributor extracts a signal component of said first local oscillation frequency from said down-converted second multiplex signal wave, and
said fourth local oscillator generates said fourth local oscillation
10 signal by a phase locking loop according to said extracted first local oscillation frequency signal component.

43. The millimeter wave band communication apparatus according to claim 38, wherein said second local oscillator receives said first local oscillation signal from said first local oscillator to generate said second local oscillation signal by frequency multiplexing or injection locking according to
5 said first local oscillation signal,

wherein said third local oscillator receives said fourth local oscillation signal from said fourth local oscillator to generate said third local oscillation signal by frequency multiplexing or injection locking according to said fourth local oscillation signal.

44. The millimeter wave band communication apparatus according

to claim 42, wherein said second local oscillator receives said first local
oscillation signal from said first local oscillator to generate said second local
oscillation signal by frequency multiplexing or injection locking according to
5 said first local oscillation signal,

wherein said third local oscillator receives said fourth local
oscillation signal from said fourth local oscillator to generate said third local
oscillation signal by frequency multiplexing or injection locking according to
said fourth local oscillation signal.

45. The millimeter wave band communication apparatus according
to claim 38, wherein at least one of said first, second and third modulation
signal waves is a modulation signal wave having a user's individual
information signal wave multiplexed over a part or entirety of said at least
5 one modulation signal wave.